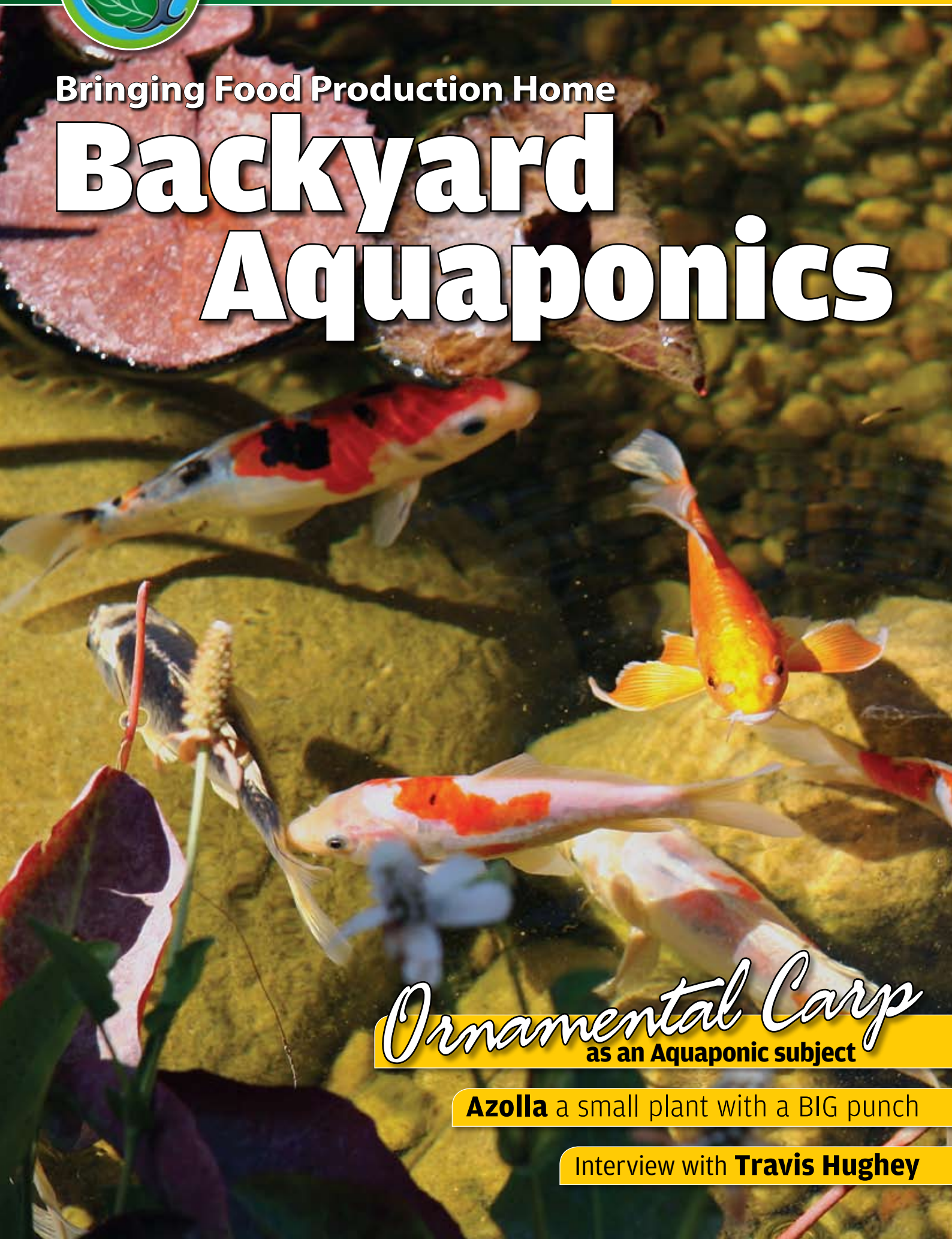
The No.1 Aquaponics magazine
for the backyard enthusiast.

**Issue 10**
Third Quarter 2010

Bringing Food Production Home

# Backyard Aquaponics



## Ornamental Carp
as an Aquaponic subject

**Azolla** a small plant with a BIG punch

Interview with **Travis Hughey**

# Welcome

Here we are at the tenth edition, quite a milestone for the magazine to make it this far. Especially in an environment where many print publications are in decline, I guess this is a good sign for the magazines future as more and more people are seeking out information on aquaponics.

We have quite a mixed bag in this edition of the magazine with some special features as well our regular sections. Sylvia Bernstein has given us an intimate insight into **Travis Hughey** with a fascinating interview. Travis has been involved with aquaponics for many years now, one of the early pioneers, and a great disseminator of information to help people get started with aquaponics. The "Barrelponics Manual" that he released as a free download back in 2005 has been an inspiration for hundreds, if not thousands to give aquaponics a go using locally available recycled barrels. We've published a few articles about Travis in previous editions of the Backyard Aquaponics Magazine, and it's been exciting to follow some of the aquaponics projects he's been involved with around the world.

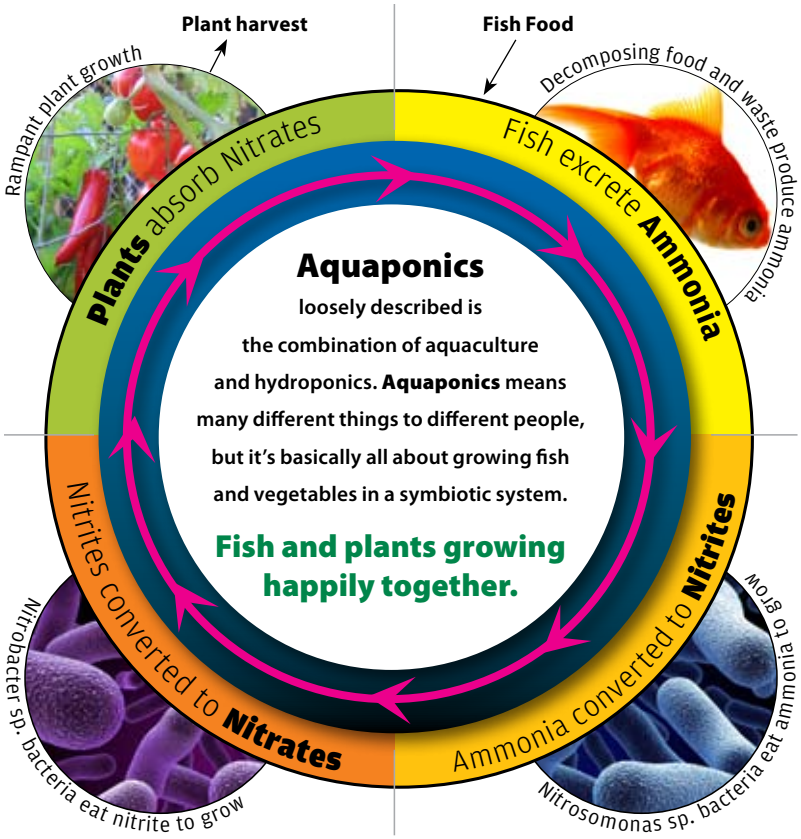
When space is tight, sometimes the only way is up. Nate has devised an ingenious method of **growing vertically with his Zipgrow towers**, very efficient space wise, and highly productive, his towers are becoming popular within aquaponic circles.

Also in this issue we look at **Ians beautiful IBC system**. For those of you that haven't seen it before Ian has turned an ugly old IBC Tote container, into an attractive and functional aquaponic system. Although this may not seem unusual because many people have built systems using IBC's, Ian has gone to extraordinary lengths to create his attractive functional system. If you care to build one of these systems then you can follow the step by step instructions included in this issue.

Of course there's plenty more in this issue to keep you busy including Fayes article on **spiders in the garden**, a detailed look at **koi**, an attractive addition to an aquaponic system, and much more. I hope you enjoy.

***Joel Malcolm,*** *Editor*

## The Nitrogen Cycle




## Backyard Aquaponics on the tube

***There is a whole range of aquaponics videos that you can view on youtube, visit the link below and see us in action!***
***www.youtube.com/user/backyardaquaponics***

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***Backyard Aquaponics Magazine*** is a quarterly publication which aims to promote the ideas of Aquaponics and home food production coupled with healthy and sustainable living.

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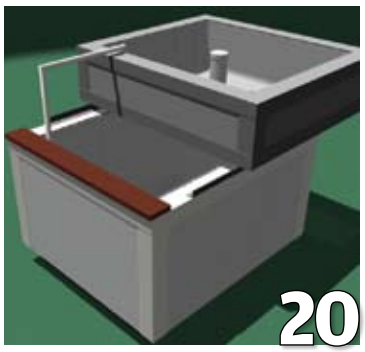



# Aquaculture Aquaponics Worm culture

## One mans four year journey of Aquaponic discovery in South Africa

By **Francois Lemmer**

**My passion started** after reading an article on aquaculture in the ***Farmers Weekly***, a popular magazine here in South Africa.

I started out with absolutely no experience in growing plants or breeding fish.

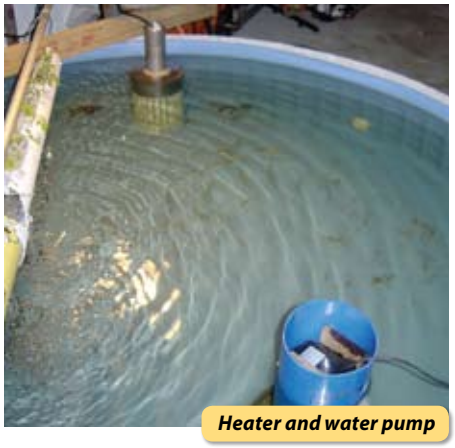
In 2006 I started in my garage with 250 Tilapia which I kept for 200 days. (At first I kept them in one dam. As they grew I had to add another dam.)

I kept the fish in 2 baby pools, each holding 1000 litres of water. I used a bio filter and when the nitrates got too high I drained water onto my lawn and replaced the water as and when necessary. I learnt about water chemistry along the way. I was very lucky because I did not cause any fish to die as a result of my original ignorance. During this learning curve I discovered just how much could go wrong. There are still aspects of water chemistry, that I have not fully grasped.

Another article, this time about Aquaponics, also in the ***Farmers Weekly***, inspired me anew. I added grow trays over the small dams in my garage. As a next step, I added a flow through grow bed outside my garage. In order to provide food for my fish I also added a few worms in a pot plant holder. I had no idea where this experiment with worms was going to lead. I started planting seeds into the worm castings, and then into the grow beds. To my surprise I observed that the worms did not only stay alive but seemed to do well between the stones in the grow beds. At that stage I had done no

***The first 250 Tilapia***

***A hiding place for the fingerlings***



***Heater and water pump***

> “My plan is to feed the fish a diet of duckweed, worms and a sound tilapia diet. **This is a way of keeping the cost of the fish food down**”

research on worms. I was actually surprised to observe that the worms not only survived in water but appeared to be thriving.

My first outside grow bed was a geyser tray. It was inspired after attending a hydroponics course on the basics of growing plants.

In this shallow tray outside my garage I grew 3m high tomatoes. (I regret not keeping a full record of this experiment.) At this stage I bought 2 books, one on Aquaculture and the second on Aquaponics. Disappointingly these books offered very little help. I then turned to the Internet and downloaded a free article of the Freshwater Institute West Virginia and 2 or 3 other articles. One of these articles was Dr James Rakocy's study on ***Aquaculture and Aquaponics***. These articles really pointed me in the right direction.

I then designed and constructed a very simple system on my brother's property. The purpose of this pilot project, was to find out if the principles of my small experimental system at home, could be transferred and reproduced on a larger scale. This is the story of the humble beginnings of my system. Although I am still planning a few minor and inexpensive improvements I am very happy with the success of my system because it meets my personal requirements. My next goal is to move to a property where I could establish my system on a large scale and without the likelihood of having to relocate the system.

In short, I have to move my system to a permanent location before I can affect any of my improvements and refinements. (My back yard)

On the right is my experimental system. I am still working on some minor changes to minimize the workload required by the day-to-day maintenance.

## 2007

During 2007 I made little real progress because of problems of my own making.

Although I created these problems I also learnt a great deal from this. My worm farm continued to expand. I was, however, experiencing an increasing number of problems with the fish….

I was about to abandon the fish experiment when I consulted a professor at the university by telephone. He provided

***Duckweed sump***

*Solids out of the bio-filter makes excellent organic fertilizer*

*Worms in fish castings*

advice on the way the fish should be treated. I decided to give it a try. His advice proved invaluable because it solved my problems.

***After this there was no stopping me!***

My system uses the minimum of water and electricity. The water flow is gravity fed 24 hours per day. In my grow beds I used different sized stone, from 6mm to 25mm. Because I do not use filters to remove solids before grow beds it means this had to be done weekly by hand. I have now added plastic baskets where the water enters the tray and this works very well. I experimented with different stone sizes, gradually increasing the stone size. I now use stones of 25 mm that provides the best water flow and filter function. I have also discovered that it is better to plant the seedlings in small plant holders to anchor the plants. Originally my grow beds were 1.2 meters wide and 6 meters long. This was changed to 300mm x 200mm x 6000mm. I also reduced the height of my dam, thus facilitating the management of the dam. At present I am the sole worker on the project. I only spend 2 hours per day on the project, including the travelling time to and from my brother's property. My main monthly expense is the fish food.

Other expenses are very low. My plan is to feed the fish a diet of duckweed, worms and a sound tilapia diet. This is a way of keeping the cost of the fish food down. I grow my own duckweed and I run a worm farm, after all! This takes care of 66% of my fish diet with 33% of their diet consisting of tilapia pellets. The duckweed also feeds the worms. This system is very close to feeding itself.

*Worms in the grow bed gravel*

It was another article in the ***Farmers Weekly*** that first alerted me to the potential of worm farming. I now have a small earthworm farm. I feed worms to the fish and also sell worms to the local households who have embraced Vermiculture. I also produce the castings that I use as fertilizer, or mix to use as fertilizer spray on my plants.

## 2008

This was the year that really opened my eyes to the potential and sustainability, of growing fish and plants in the same system. My system was proving itself by showing very good results. I started testing plants and monitoring their growth. I found it fascinating to experiment within my system. Expected and unexpected results and discoveries continue to keep my enthusiasm alive. The simple task of opening a packet of lettuce seed, spreading them between the stones in a growbed and watching the seedlings grow

*First lettuce crop*

into beautiful lettuce plants remains an exciting experience.

## THE ECO SYSTEM

The whole idea of sustainability started sticking in my head. The dream of sustainability is not only attainable, but achievable by someone with no knowledge or experience prior to 2006!

## SUSTAINABLE

At about this time I realized just how easy it is to sustain a system by letting tilapia breed and restock with new fingerlings within the same system. It is a demonstration of the ancient law; the survival of the fittest.

These fry were bred in my duckweed dam. The bigger tilapia I put in my duckweed dam at the beginning of 2008. All of this happened with very little effort. The most important thing I could do was to try and maintain good water parameters. Nature takes care of the rest.

I started selling the bigger fish to farmers for their dams and restocking my system with my own fingerlings. Soon I started growing fingerlings and then separating the bigger males from females. The females I sell and the males are returned to the system. Males grow faster than females so the sorting really takes care of itself. The restocking of my system is based on this. The fingerlings float in a floating cage in the big dam from where they are sorted.

*Floating cage to protect the fry*

*Bigger Tilapia mill around the cage*

At first I kept my tunnel open for 6 months and covered with plastic for 6 months. I had very good results with plant growth. Everything I planted did very well. I grew peppers, tomatoes, spinach, beans, garlic, lettuce, sweet corn, basil and other herbs, and flowers. The system runs itself on minimum cost and time.

I started adding worms to my grow beds every other day. I believed that they will survive in the grow beds and I wanted to make sure that the worms in my grow tray at home was not merely a coincidence. I have now proved that the worms are happy in such a system as long as they have food to eat and oxygen in the water.

I am totally convinced of the role worms can play in an Aquaponics system. The worms are worth their weight in gold.

I suffered some losses during 2008 as a result of a stupid error on my side. One morning, after feeding the fish two hands full of worms I had brought from home the previous day, I found 50% of my fish dead. I was baffled. I needed to understand what could have caused this loss. Mentally I retraced my steps of the previous day. I remembered a plastic packet that I had dumped next to my bath full of worms.

I had previously used the plastic packet to collect the leaves removed from an ailing plant that I had treated with some chemical poison or other. I learnt a valuable lesson: Don't ever again use any of those chemical herbicides or insecticides on anything. This made me more acutely aware of nature and the way it should be treated.

I have photographs of my system over the 4 years it has been running. If there is one thing I can recommend it is this: **Keep records and lots and lots of photographs**. My collection of photographs provides a good record of my system. It shows me when I had good growth, as well as the season/time, and the number of fish at any given time. These are all things you may want to refer to.

I am aiming at a system based on that of Dr James Rakocy's study on Aquaculture and

*Peppers enjoy the heat*

*Garlic*

*Vegetable variety*

Aquaponics. I aim at a system containing the maximum number fish per 1000/L of water and maintaining high feeding rates to achieve maximum growth per shortest time. Down the line I hope to make a living from nature following nature's own principles. The past four years was used to experiment, and I adopted a wait and see policy. Way back in 2006 my main focus was fish farming. I did not plan to grow my own low maintenance vegetables. What I grew during the preceding years I used as fish food in my system, and later also as worm food. I have never wasted anything. I started my worm farm with 50 worms.

## 2009

I started experimenting by planting per tray to establish a planting cycle. Some plants grew well, some struggled. I was forever looking for answers within the combo of worms and fish. If a plant did not do well I would try all my own Vermiculture remedies and 9 out of 10 times I managed to improve their growth. My 4 years of exploration and experimentation drove one overriding conviction home to me: Incorporating worms (Vermiculture) is the most important and valuable component to any Aquaculture and/or Aquaponics enterprise.

But I believe its potential is far greater than just the breeding of fish or the growing of crops. To make this really financially viable on a big scale you should embrace all aspects and possibilities, from the propagation of seeds and the breeding of fingerlings, to the production of organic fertilizer.

You have to do it all if you wish to make life alot easier … and more sustainable.

To make my system more sustainable, I also started planting an ornamental grass that is easy to grow and requires no or very little maintenance.

I produced red sunflowers as an experiment. I took them to a florist to gauge the level of interest and the blooms were immediately snapped up at a very good price. The possibilities are virtually unlimited. As you develop and expand your own system you will find that production becomes more and more economical.

By combining a few manageable operations and by developing the right crop cycles Aquaponics can be highly viable as well as worthwhile. Personally I like the crops that are grown with the least effort and time spent on them. Garlic and celery are examples of crops that are easily grown and always in demand. Of course it is gratifying that customers are also impressed with the quality, taste and flavour of my produce.

My tunnel was covered in plastic for the first 11 months of 2009. A covered structure provides advantages and disadvantages. An obvious advantage is that you have fewer insects. It is very favourable for winter but in summer it turns into a sweltering hot house. Even with our winds and good ventilation my inside temperatures reached 38°C. This in turn creates very warm water temperatures. This caused a major problem. To solve this particular problem I used an air pump to add oxygen to the water. During this time I was feeding the fish a maximum of 25 Kg food per 10 -15 days with no waste. (between 1.8-3 kg of food per day) I was pushing it but I wanted to test the response of my system to this and I had learned to rely on the signals the fish send out. The plants also took a beating from the heat but I regarded this as part of the learning experience. All the time I upped my stock rates to where I am now. When things got rough I would sell all/most bigger fish and start the next growing period. My aim is to build a system with a stock rate starting 30kg /per 1000 l/water to ..... 60kg. It all depends on how much my system can manage and how much I can handle.

The plastic cover is one way of gaining between 3-5° in winter conditions. In summer you simply remove the plastic covers.

***Oxygenation is vital at high fish density***

***A basket helps remove solids***

***Water flow by gravity into the grow beds***

Heating water is very important for tilapia growth, but heating is expensive and that is why I am looking to nature for a solution to this problem. I believe it is possible and simple. I have tried and tested various ways to heat water as part of my system. I have experimented with various methods of compost heating. I designed and built this upright heater. I cannot yet say whether it is a success. I have filled it only once. I believe it will work once I have the system in a location that will allow me the time to monitor it. I shall also investigate different possibilities like the sun and the decomposition of organic material. Because it is important for me to keep costs down

*Inside the greenhouse CD's hang to discourage birds and monkeys*

In November 2009 the wind blew my plastic tunnel down! I can honestly say that it was an ill wind that did me a favour with that load of fish in that heat. I felt totally defeated. For the remainder of 2009 I just abandoned my plants and planting until I realized I had to do something if I wanted to keep my fish alive.

This apparent set back happened during a very hot spell. In addition we were suffering a severe drought and water restriction resulted in far from ideal conditions.

## 2010

As I am writing this article we are in the middle of winter.

My plants have been demanding most of my time. I have been trying to establish a planting cycle. I strive for a system sustaining healthy fish and plants, but the fish have now not eaten well for 8 weeks. It has become a major challenge to keep the plants green and growing. Because of my work and testing, the value of worm tea and castings produced by Vermiculture, I can say that I have proved that the worms are a very valuable part of the cycle. My plants are still growing and I can maintain the good growth by spraying plants with worm tea and adding worm castings every 2nd day. As soon as you break this routine the plants start deteriorating. If this happens I believe it can be rectified with generous additions for 2 to 3 days.

*Outflow from grow beds into Duckweed pond*

I love all these challenges. I believe Aquaponics is one of the most reliable tools to ensure sustainable food production. We may be amateurs but often it is our interest and our passion that produce solutions for the future.

Personally I do not believe there is one best system. It is rather a matter of how you utilize what you have in your situation and under your conditions.

My system is based on my requirement of minimum maintenance, the restrictions of a very small budget and the desire to produce maximum food on a small footprint. My system is a system still in development. The amazing results obtained during the pilot project have, however, encouraged and inspired me. My dream is to build a small micro farm based on interconnected and mutually supportive principals, based on the wisdom of nature and on respect for the environment.

The possibilities are unlimited. Allow your mind to dwell on a perfect eco system.

I believe that my experiment of the last 4 years has only scratched the surface of what can be achieved.

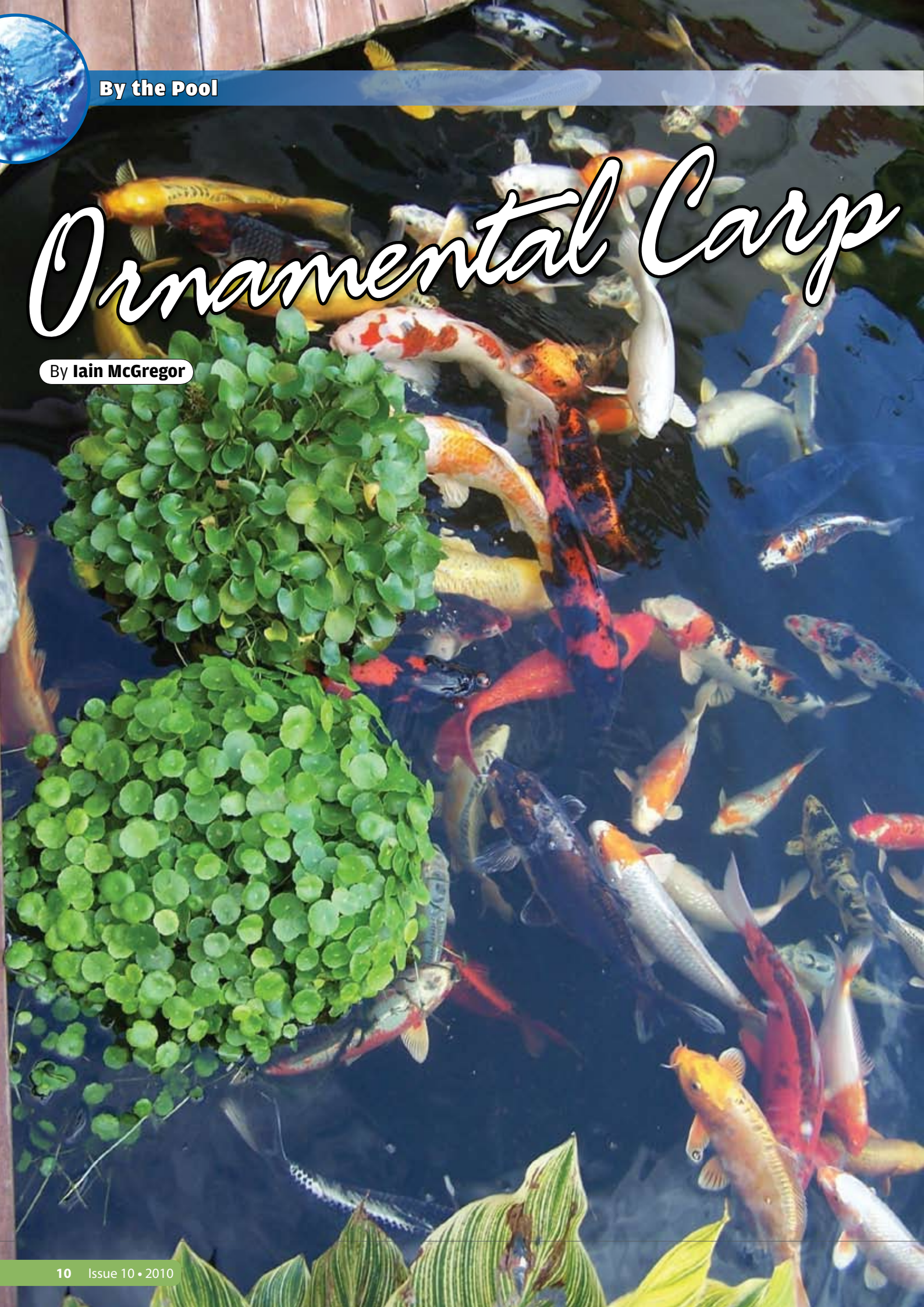
## WHO IS TO SAY WHAT THE LIMITS ARE?

Who knows what can be achieved once I can control all the important parameters. When I harvest my next batch of fish I will be in a better position to announce whether I have achieved my goal of producing. Kg. fish / Per 1000 Litres water.

All of this started as a hobby and has grown into an all-consuming passion. I am the first to admit that I have alot to learn - but I am a keen learner. I do not dream of saving the world but I want to feed myself and my family and I want to live in harmony with nature and its laws. I have walked this path for the past four years with very little outside help, support or encouragement. It has convinced me that we have access to a food machine, provided that we observe the parameters layed down by nature. ●

# Ornamental Carp

By **Iain McGregor**



# as an Aquaponics subject

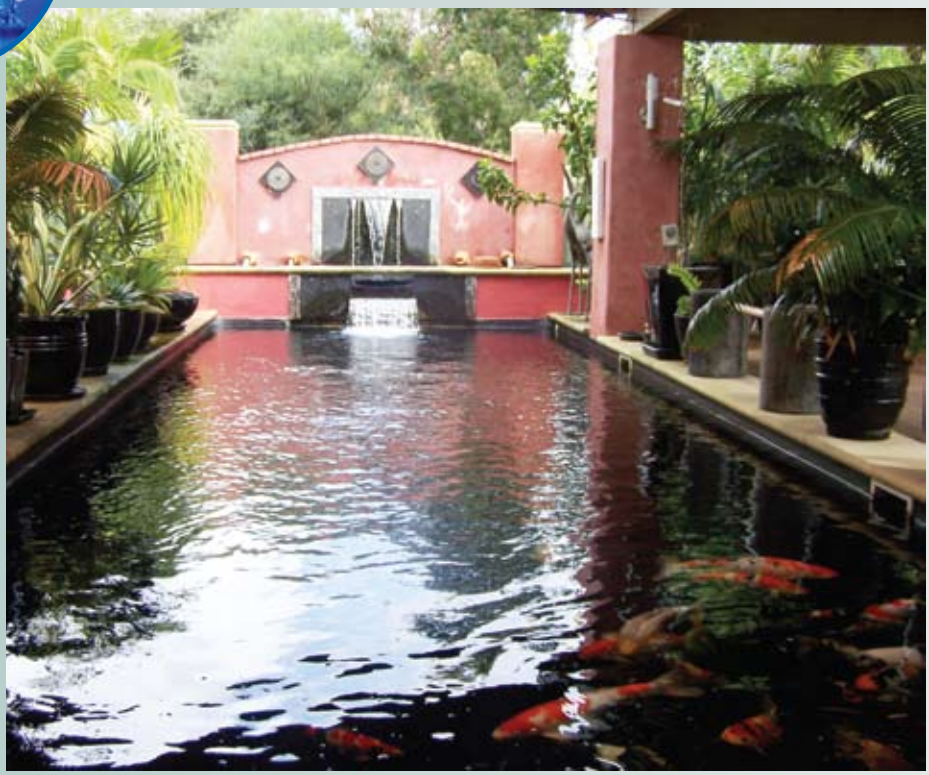
## A fasinating look into the history and beauty of Koi

**Human beings** and the fish *Cyprinis carpio*, or Carp have had a long relationship together, initially this relationship was one of food as the intention, but this developed into a fascination for the beauty of the species, here we will explore its journey through history and into the future. Japanese coloured carp or KOI, have a long history of culture as a dual purpose fish - they can be eaten and kept for their ornamental qualities. Initially this fish was a protein source for people across Europe and Asia. As it spread to remote areas human culture started to mould the genetics of *Cyprinis carpio*. It was selected for high growth rates and reduced numbers of scales for ease of preparation for consumption.

However, in rural China and Japan another pressure was to change the destiny of this fish and launch it worldwide. Parts of the country suffered from extreme winter conditions and the locals were snowed in for an extended period during this time. Fish for food, were being placed in an indoor pond, inside the homes, and used to get the snowbound inhabitants through this difficult season. This environment of isolation led the genetics to become inbred, leading to the mutation of colour . The unusual specimens must have gained much interest and a movement of comparing the fish during the spring and summer began – and this is how the novelty started.

As colours appeared and were mixed, new combinations came to be, breeders selected superior specimens and soon this diversity needed order. This basic grouping of thirteen coloured varieties was settled for as a rough guide and a standard. One of the more amazing of these mutations is the trait that gives the fish a 'metallic' look, so completely divergent, is from the original brown-grey fish. The lustre of the skin on

*A butterfly kohaku*



*Hikari muji mono* and *Hikari moyo mono*, seems to glow almost generating its own light.

If the kaleidoscope of colour was not enough of a new factor, amazing reflecting scales looking like diamonds appeared termed *Kin* or *Gin Rin*. Within a few years of breeding selected individuals this trait could be expressed in five ways each illuminating the scale with a different facet. When combined with the metallic fish a very handsome product is the result.

This fish started its close association with man as a food fish valued as an easy care, hardy culture subject with a large reproductive capacity. In less than 150 years of culture ornamental carp or *NISHIKIGOI* have graced garden ponds and been collected and exhibited by enthusiasts

***Different levels in the pond creates space for plants to thrive***

across the globe. This appreciation of art placed on a fish, reaches its peak at the All Japan Show, a place where fortunes are made or maintained by winning the grand champion fish. And prizes for the best fish are only given after the decisions are made by teams of judges.

The main feature of koi, is colour. This is the trait that has made them so popular. But what should you look for when selecting koi? The appreciation of koi has an aspect of art to it. The balance of the colour over the body is important and when three colours are combined this aspect of balance will be harder to achieve. Fish with colour only on one side or just one half of its body are considered flawed. Intensity of a fishes colour is another main feature to pay close attention to, deep bold colour is required with a clean cut between the second and third colours, a peppery or blurred colour borders is also a fault. The actual pigment in the skin on a koi can change in intensity and can also come and go. So when choosing a group of quality young fish a percentage of attrition is to be expected as they grow.

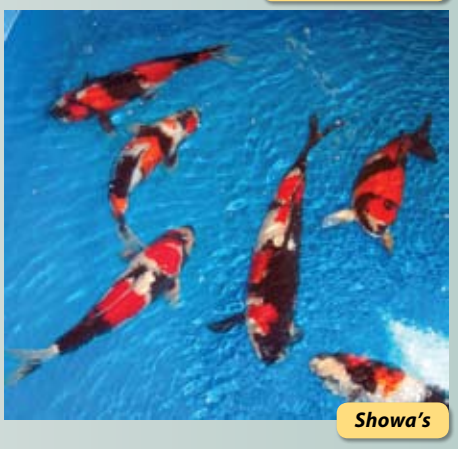
Red is the colour of most interest in show koi and it's a group termed *GO SANKE* that most of the attention is on. These colours are red and white (*KOHAKU*) and red, black and white (*SHOWA* and *SANKE*) It is always a *GO SANKE* coloured koi that will take out major prizes. Other combinations that will provide contrast are black and white (*KI UTSURI* and *KUMONRYU*), blue (*SHUSUI* and *ASAGI*) grey and red (*GOSHIKI,KOROMO* and *AIGOROMO*).The metallic coloured fish are available in the above patterns and have a couple of different ones.

*HARIWAKE* is white and another colour. *YAMATONISHKI* is a white fish with another colour with a black overlay *OHGON* is a single colour such as white, gold or orange. *MATSBA* is a single colour with a net like pattern overlayed, when the net pattern is overlain on a two coloured fish this is termed *KAJAKU.*As a layperson the best advice is to choose fish that appeal to you and try to get as wide a range of different colours as possible.

Long fin or butterfly koi are thought to have originated in South East Asia during the 1970s and distributed worldwide a short time after. The long fin trait expresses itself with fins about twice the length of normal carp and some fish show great individuality of fin shape amongst themselves, such as with pectoral fins having each ray longer than the surrounding webbing appearing ragged opposite to smooth entire finned fish.

Other traits linked to this gene are the longer mouth barbles and larger nostrils that extend outside the head cavity. They are also very robust individuals that grow strongly. As butterfly koi became a component of ornamental koi, the governing body became faced with a decision as to whether these fish had a place in the exhibition circuit. This Japanese group the ZNA, made a decision against recognising the longer finned fishes. This decision may have stunted the rapid enthusiasm that serious hobbyists had for them. The reality remained that when a person who had no interest in this aspect was given a choice between short and long finned fish for their garden pond the latter

***Gin rin butterfly's***



***Showa's***

***Kohaku's***

are usually chosen. These average pond keepers began creating an undeniable market for the illegitimate style. In recent years American koi shows are now beginning to give butterfly koi a class and even some Japanese fish farms aim to service this part of the market.

Most pond keepers will experience spawning when their fish are mature and koi need no real special treatment for success. Problems arise when koi fry appear and if their needs are not met huge attrition will soon follow. Koi farmers breed fish in bloodlines that aim to produce only one or two colours. Almost all accidental spawns with a variety of colours will result in poorly marked fish with little or no value. When breeding is looked at in an aquaponics view other traits may be the aim such as fast growth or heavily framed bodies.

When several species can be cultured in the same body of water, in a complementing way, a greater volume of biomass can be harvested from a given unit of water. Well known as a peaceful pond fish and can cohabit with a wide range of tank mates. Koi mix well with other fish that have a similar trophic level, such as tandanus, catfish and silver perch. They can also mix well with marron but this works best in an extensive situation as the fish soon show some signs of damage when held intensively. Predatory fish like barramundi and trout may need some trials but koi and black bream are a poor mix with the latter harassing the koi mercilessly.

The dietary requirements of koi are easily met, they are omnivores adapted to bottom feeding. Most prepared fish foods will suit with the higher quality feeds giving proportionate results. When comparing one feed against the other protein is the factor of most impotence with colour enhancers and fat also worth investigation. Koi can live on prepared feeds indefinitely but a varied diet with vegetables will give the fish a complete ration. Frozen peas and corn are a favourite and broccoli and lettuce leaves also rate highly.

Koi have a small following of recreational fishers in Australia, as their large size makes for a good fight. Internationally carp have quite a large fishing following, with competitions and fishing tours around the world.

As an aquaponic subject koi again can have a dual purpose. As pets in this style of culture they will prove to be hardy, easy care fish that will be long lived companions

*A Koi show*

*Sanke's*

that will not be dramatically influenced by seasonal extremes

A big question for the future for this fish as a realistic aquaponic subject is: Can the Australian public view koi as a food fish? Even today carp are consumed in Asia, Europe and the Middle East as a part their diet . In Australia koi are pets and carp are pests that make good fertiliser. If handled in an appropriate way koi have the potential to be included into the mix. Selective breeding has the potential to shape this fish into a very fast grower as the Japanese koi farmers have proven. And to reduce the chances of emotional attachment choose white, grey or orange fish, no one too charismatic. White may prove to be the best choice; we have seen white carp commercial cultivation and white gives a nice clean fillet.

As a next step it will be interesting to see where Australia ends up, in regards to growing koi as a food source. All the factors are in place, except the western view to this fish as food. Perhaps other avenues such as making koi into stock feed or fertilisers may be the way to go. Even if you don't want to eat koi, you can still grow them for their beauty, plus they can help generate lots of veggies that they will be keen to share with you.

# Azolla

By **Faye Arcaro**

## Small plant with a big punch

**We are now** talking of the tiniest aquatic plant alive today and it is in fact a fern! However it's not the size that counts these days, rather what it can do for us. *Azolla caroliniana* floats on water surfaces of rice fields, canals, and small ponds or anywhere water accumulates and stands for a period of time. It may cover the surface of still water completely because it grows rapidly and multiplies profusely. It is sometimes regarded as a weed and be seen as invasive.

It is similar to duckweed and the two are often confused. It has a striking olive green colour in spring and gradually changes colour by mid summer to a rusty hue. Many surfaces along roadsides will appear red, making the plant more noticeable. It is also called Mosquito Fern and Fairy Moss because it makes it impossible for mosquitoes to lay their eggs in water covered by this diminutive plant.

Azolla does not fall under the normal land fern genre because of its size and as such is classed in the genus of seven species of aquatic ferns and is the only genus in the family Azollaceae. It is propagated by division.

*Azolla*

***Above: The half frog half tadpole is emerging from a yabby tank under the growbed. The plant in the picture is duckweed the smallest flowering plant and often mistaken for azolla***

> “There is a radical idea which involves azolla in **capturing the sun’s energy** rather than using expensive solar cells”

What makes this tiny plant so special is the way it lives a symbiotic life with other plants such as in rice paddies for instance. Each little leaflet is fitted with a pouch which contains a blue-green algae known as *Anabaenae*. This algae miraculously converts the atmospheric nitrogen into another form which other plants around it use in their development. The fern only uses a tiny portion of the nitrogen as it is produced.

Once the plant dies off, it sinks to the bottom, releasing the remaining nitrogen into the water for other organisms to feed on. Many rice paddies in Asia will be covered with the fern during the early growing season. Once the rice grows and shades the fern, it will die off and start the cycle of nutrient sharing again. It is known as Mother Nature’s natural and cost-free bio-fertilizer.

Another fantastic and successful example of using azolla can be found in Japan. A farmer in Kyushu started using rice-azolla-duck programs in his rice production. He is an organic farmer and does not want to use chemical pesticide on his rice paddies. His main problem was weeding, so he introduced a hybrid duck for this purpose only. The duck effectively eradicated the weeds by disturbing the soil surface. He then introduced azolla for its nitrogen-nutrient properties, mainly for the rice and as a protein source for the ducks. The ducks also did another great job at keeping the azolla at bay and spreading their manure providing more organic food for the rice. It is a system which is being used by many Japanese organic farmers today.

Azolla is sensitive to wind and desiccation. It grows really well in a depth of a few centimetres of water, but will quickly die off if it dries out. The wind on the other hand is a problem as it pushes the fern to one side of the pond where it accumulates in a dense mass. This often leads to it dying off. Strong winds which change direction often will fragment the plant as well and stems its growth or no growth will occur at all. It cannot withstand prolonged freezing and is often grown as an ornamental plant at high latitudes which prohibits it from becoming a weed.

## REPRODUCTION

It is not only a super plant for feeding other organisms; it can also reproduce in a way which sets itself apart from other members in its group. Spore formation takes place during sexual reproduction, but our little azolla makes sure that it produces two kinds. In summer the plant will form numerous spherical like structures on the undersides of the branches. These are called sporocarps. The male sporocarp is distinguishable by its greenish-reddish colour and looks a lot like a spider’s egg mass. Inside this mass are male sporangia (microspores). They are extremely minute and are produced inside individual microsporangium. They clump together which is most curious for this type of plant.

The female on the other hand has sporocarps which are even smaller than the males, containing one sporangium and one functional spore, but the individual female spore is considerably larger than a male spore and is termed a megaspore. The azolla plant has microscopic male and female structures which develop inside the female and male spores. The female organ protrudes from the megaspores and bears a small number of sacks each containing a single egg. The male has a single antheridium which produces only eight swimming sperm. The barbed bristles on the male spore clusters are assumed to cause them to cling to the female megaspores and thus facilitating the fertilization process. Very eloquent and well planned for a miniscule plant wouldn’t you say?

## CLIMATE PALAEONTOLOGY

Fossil records show that this plant species has been growing for at least 80 million years, evolving into its present form. A study done in the Artic reported that azolla played a significant role in reversing a greenhouse-effect increase, which occurred 55 million years ago. This effect subsequently turned the North Pole and the regions surrounding it into a hot tropical environment. What they found were large dense patches of azolla growing around lakes which were formed by the climate change, finally consuming enough carbon dioxide, reversing the greenhouse-

*A healthy underbed yabby tank with a combination of azolla and duckweed floating on the surface*

effect. So we should not underestimate the tenacity of this small plant as it seems like an organism which could help or destroy humankind in the future.

## EXCELLENT SOURCE OF FOOD FOR ORGANIC FARMERS

Because azolla sets free nitrogen into the soil it is traditionally cultivated for wetland paddies and known as a bio-fertilizer. However it is also finding its way as a sustainable livestock feed. Because it is rich in proteins, amino acids, minerals and vitamins it is fed to fish, worms, pigs, ducks, chickens and dairy cattle with a reported increase in milk production in the latter. It was also reported that broiler chickens increase in weight and egg production of layers increase when compared to conventional feed.

It makes a fantastic companion plant in fish tanks,ponds or paddies and could easily prevent competition from other plants aside from its companion.

## HARMFUL PESTS

The Lepidoptera and pyralidae larva are considered most harmful to azolla. In tropical regions webworm (elophyla) and case worm (epheosispsis) can radically harm it. In temperatures higher than 20-32 degrees C, the damage is usually severe and irreparable, as the growth speed of azolla will slow down while growth of the insect infestation increases.

## FAR REACHING INTEREST INTO AZOLLA

There are many proposals circulating around the world on how to harvest sunlight and turn it into electricity and harvesting algae and turning it into fuel. Both are great ideas and many inventors and scientists are working around the clock to come up with sustainable ideas which are cost effective for poor countries that still rely on coal and fossil fuels to drive their economies.

There is a radical idea which involves azolla in capturing the sun's energy rather than using expensive solar cells. It would come down to economics in the end and obviously more research is necessary. Dried algae and azolla flakes can be burned at night as well, which renders storage unnecessary.

Of course there are a myriad variations of this idea, like fermenting the plants and collecting the methane product and then using that to fuel power stations for instance. Only the future will tell us the direction we need to follow in this regard. One thing for sure though is that we need to think about getting away from expensive oil which cripples economies and holds them to ransom if they don't have any of their own.

## GROW YOUR OWN

It is possible to grow the fern in a shallow pond in about 15cm of standing water. A pond size of 2m x 1m is more than adequate. You can also grow freshwater crustaceans such as yabbies as well as goldfish and even pygmy perch in the same pond. Azolla will start to multiply immediately and should be ready to start harvesting within 20-25 days in warm conditions.

Harvest the fern in baskets if you want to convert it to compost. Some of the favourable conditions under which azolla will flourish are: freshwater, a day and night temperature ranging between 32-20 degrees C and partial shade. Azolla makes an ideal addition to the worm farm and then you can feed the worms to the fish, growing your own fish food has never been easier. Have a look around the house and garden for spare containers, maybe old baths or something similar. Grow some azolla and feed your livestock if you have any. Once you have made your initial purchase you will never have to buy again. If you don't have any chooks or small animals around, then you can always feed it to your plants. It will also act like a sponge soaking up water and retaining it where it lies. Add some to your potted plants, especially delicate ones, to stop soil disturbance when watering. You cannot go wrong with this super-plant!



# Allan & Jenni Griffiths

# Backyard Aquaponics System

By **Allan & Jenni Griffiths**

**So we purchased** our aquaponic system at the beginning of September 2009. 2 growbeds on stands and we have one fish 2000L tank. We put in 4 largish trout to get the system up and running for bacteria/nutrients etc for the grow beds.

We started off with seedlings for the first batch of veggies but now we use a combination of both seed & seedlings for our veggie grow beds. We have harvested so many veggies from the system. We certainly didn't imagine at the beginning that we could possibly get so much produce from the system. In September 2009 we put in 1 x Grape Tomato seedling and this has not stopped fruiting, even all through our frosty winter, it's almost unbelievable and the plant is flowering even more now that spring has arrived. I cannot believe how many grape tomatoes we've harvested from this one plant, we've given away loads of tomatoes, because we couldn't eat them all.

**We have in our grow beds:**

- **Silverbeet** [all year]
- **Strawberries**
- **Chillies** [all year]
- **Snow peas** [they don't stop fruiting all year round either]
- **French Beans**
- **Broccolini**
- **Capsicum** [produced lots of capsicums]
- **Tomatoes** [grape tomato all year]
- **French Radish** [these get huge]
- **Celery** [this grows all year]
- **Baby Red Cabbage**
- **Baby Cauliflower**
- **Lettuce** [various varieties]
- **Beetroot**
- **Garlic**
- **Basil, Mint & Laksa Curry Leaf** [Vietnamese Mint]

We tried cucumbers and carrots, but these were not very successful, the cucumber vines were hopeless to try and support and the carrots didn't grow very well for us.. So as you can see we have quite a variety of veggies that have produced bumper harvest for us and mostly all year round.

We had a few teething problems with our fish about 3 months into production. The first lot of 4 [Sept 09] grew another 1/3 of their original size in about a 6 week period

before we harvested them in November 2009 as the weather warmed up, and they were yummy. We then introduced 50 barramundi fingerlings for the Summer period. We topped up the fish tank one evening with a hose from our bore but forgot it was on, and overnight all the Barramundi died due to lack of oxygen from the low oxygen bore water. This was a very hard lesson learnt and now we set a timer whenever we top up the fish tank.

After that little 'embarrassment' we got another fresh supply of trout fingerlings for our tank. Much to everyone's surprise these trout survived the very hot Summer [Jan - April 2010], we had always read that trout don't like the warmer water, but ours seemed to thrive. We put up a 3x3 metre pop up shade shelter over the tank for the summer months, and the hottest water temperature we recorded during the day was 26.7 degrees when we had three 41 degree days in a row, but each night the tank would cool down by at least 4 degrees. We didn't lose any fish over the summer months and have been harvesting that crop since May 2010 [approx 6 months from fingerling to plate size].

We put some black piping on our water tank roof to heat up the trout tank water during winter and try and keep it to an optimum 18 degrees for the trout, they do seem to be more active and eat better when the water is about 18 degrees. If the water temperatures drop to about 10 degrees they are nowhere near as active.

*Rainbow Trout 10 months old; top trout 850g, 380mm; bottom trout 650g, 370mm*

We were really surprised at how quickly the trout grew. Our average plate size for trout is 370mm long and 700gms in weight. So Friday's is now 'Tommy Trout' night for us and we either oven bake or smoke them.

All in all we are so pleased and rapt with our Backyard Aquaponics System, fresh fish & vegies all year round and whenever people visit they always have a look at our system and are envious of how well it harvests so much produce for our household all year round. ●

# Do it yourself IBC SYSTEM

An IBC in its basic form is not a thing of beauty, nor a joy to behold. It is utilitarian at best and an eye-sore at worst. Remember: Beauty is only skin deep, Ugly is all the way to the Bone!

By **Ian King**

**Having seen** an attempt to produce an Aquaponics System from IBCs and market them commercially, note was taken of some of the design features that were incorporated in the transformation. They still looked like IBCs, but more on the tidier side than a great majority of D.I.Y. IBC AP systems that abound.

I was given an IBC a while ago and was still figuring out what to do with it, as far as Aquaponics was concerned. A buried sump; too much digging and permanency of position, a Fish Tank: yes, but what about the Grow Beds. Combined FT and GB: yes, but all the ones I had seen before had been split, separated and assembled as individual units with rough cut edges, exposed cut steel framing, sitting on everything from a couple of masonry blocks to straight on the ground. A couple were wrapped with UV protection, but most were just bare boned! There must be a neater more aesthetically pleasing way of achieving the AP goal using these readily available beasts.

Using ideas I had already tried and tested in 'dressing up' my Mega-bin Fish Tank and incorporating some newly developed design features was the motivation to design a workable yet appealing selfcontained unit from my IBC. Insulated Mega-Bin Fish Tank with IBC in background.

First thing was to determine what sort of IBC I had and get all the basic dimensions required to produce some design drawings of the system as it developed. I had some basic parameters to follow and I wanted to incorporate them to best advantage, using what I had at hand or that wouldn't cost the earth to achieve.

IBC ready for decanting saved water and moving for fabrication.

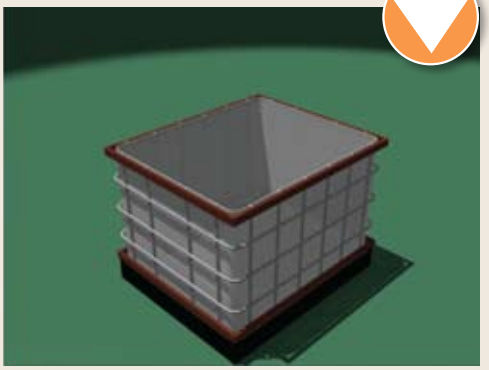
Grow Bed in open position

**The following graphics outline the basic principals in the construction. They are only indicative at the moment and no detail has been added as yet but it should give the idea.**

**IBC with top of liner and top of framing cut off for re-use.**

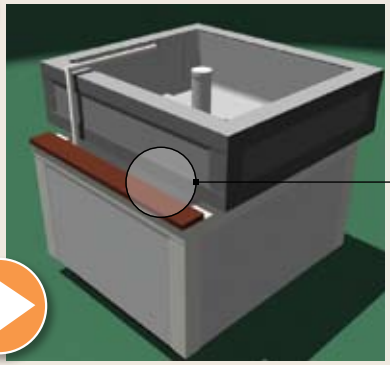
**Front shelf and castor track angles fixed to Fish Tank top.**

**Top and Bottom timber trims around frame to mount cladding**



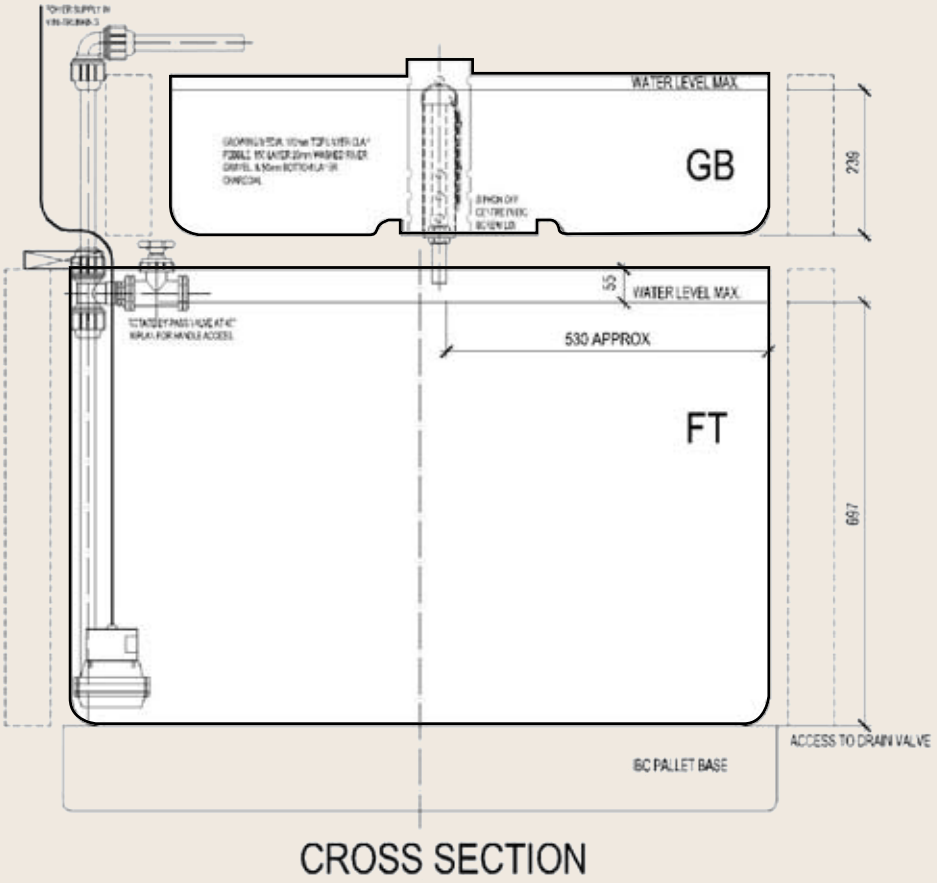
**Grow Bed completed: Mounted on Fish Tank tracks and rolled to open position.**

**Grow Bed in the closed position**



**EPS core Cladding screw fixed from inside and liner replaced.**

**Top and Corner flashings installed.**




CROSS SECTION

Drawings and design courtesy of IAN KING DESIGN

# The quest for verticality

## Aquaponic Production in Laramie, Wyoming

By **Nate Storey**

**When I walk into** my greenhouse, I'm greeted by humidity and the smell of life. White towers hang above my tanks with strawberries, herbs and greens tumbling down their sides. It's a welcome sight here on the high plains of Wyoming where the grass is green for about 1 month out of the year, and the rest of the year it's dry and brown or covered by snow. I usually walk in and take a deep breath of the oxygen rich air (another rarity at high elevation) before getting to work testing water, watering seedlings and cleaning skimmers. Of late, the strawberries have required a lot of hand pollinating too- work that I enjoy. I've been paying a lot of attention to my strawberry system lately as it's just recently been converted from a pure aquaculture setup to an aquaponic one- stocked with carp and tilapia rescued from my skimmers. My systems are roughly identical now, having two 500 gallon tanks and a 1000 gallon settlement tank that also functions as a bit of a brood tank, allowing my immature fish to grow to size before being washed into my skimmer for transplant. Water is pumped from this settlement tank up to the tops of my towers, where the irrigation water trickles down through the tangled matrix of bacteria covered media, worms and plant roots.

When I describe my aquaponics setup to people it usually takes a fair bit of time. This is cattle country, and sometimes the concept of greenhouse production is far-fetched, let alone the concept of building a mutualistic community of plants and animals, or growing plants in vertical tubes. For people

> "As someone with deep roots in the agricultural community, it's easy to get gloomy about **the future of food production**"

unacquainted with aquaponic production, I have to first explain that I'm using plants to clean aquaculture water, or that I'm using fish to feed plants. Once this hurdle is past I explain how my plants are grown- sandwiched between two media inserts made of recycled water bottles. They're usually a bit taken aback. "You grow your plants in plastic?" I respond in the affirmative and then it usually goes one of two ways- either an eyebrow raises quizzically, their head shakes and that's the end of it, or their eyebrow raises quizzically and the questions continue, as they should. I'll be the first person to admit that what I do seems a bit strange, but it works, and I think it's safe to say that as land grows even more scarce and more expensive and the local food movement continues to emerge, we'll see a lot of interesting things happen to food production.

I first became interested in vertical plant production after considering rooftop agriculture and agriculture in developing nations. Aquaponic production was a natural fit as it was simpler and more accessible than hydroponic production and also supplied animal protein. Initially, I got really excited, built an aquaponic system with vertical aeroponic tubes (the plant roots are suspended in air and a nutrient solution is misted down through them) and struggled with my system for a year and a half before I decided to start over. As I began work on my second system I had a list of considerations- some necessities, some just luxuries:

*Custom designed hook allows towers to zip up anchoring plant roots*

1. Plant production components needed to be lightweight, modular and highly scalable so that they could be easily taken down for harvest, planting and live produce sales, and could be applied to any size system.

2. The towers had to contain media to anchor the plant roots, provide biological structure and for temperature moderation in the root zone. The media also had to have massive biological surface area, minimally equivalent to that of an appropriately sized gravel bed, ideally double or triple the biological surface area of a gravel bed.

3. The towers need to only have one growing face for transportation, handling and light penetration reasons.

4. The towers had to be simple to apply automation equipment to.

There were a few scrapped designs and a lot of rejected material, before the right components were found. I ended up using square vinyl pipe with a custom made polyester matrix material as media. A gap was cut down one face of the pipe and the media was drawn in with a special hook. As the media was drawn in, plants were placed between the media halves with their shoots extending from the gap and "zipped" into the towers. The towers were then hung from a pipe structure over my fish tanks and irrigated at the top.

My first experimental crop in the system was mustard greens, kale and bush basil. My goal was to pick plants that were hard to kill and grew like weeds. Now before I proceed I must assure you that I have very seldom been successful on my first try at anything in life, and I really expected the towers to be yet another failed iteration on my quest for vertical plant production. So I was really quite surprised when the towers not only did not fail, but flourished. The first tower of mustard greens I harvested yielded 22 lbs of good greens, kale yielded around 15 lbs per tower (I think my greenhouse was a bit hot for it), and my first basil tower yielded 13 lbs of basil after 6 weeks in the tower. I was using 55 gal trash bags to haul it all home.

The towers progressed, improvements were made, and I ended up with 16 towers providing biological filtration and nitrification for a 2000 gallon system. My

*Aerial view showins hanging mechanism and irrigation arms*

*Variety of plants suitable include kale, mustard greens, basil and barley*



fish have grown and now at a little over 300 pounds of fish I need to add a few more towers. I just recently converted another 2000 gallon aquaculture system over to aquaponic production and planted the towers to strawberries. I have incorporated Red Worms into the towers and they do very well in them. So far everything I've grown in the towers has been highly productive, including a number of different basil varieties, a variety of spring greens, lettuces, mustards and kale, as well as barley and strawberries. I mass the towers together, spacing them 14 inches apart in one system- my goal is to determine how closely I can space them before production is impacted. The towers actually do surprisingly well this way.

Here in Wyoming the sun stays low on the horizon during the winter months. Because the sun stays low, light hits the towers horizontally for most of the winter, allowing light penetration into the massed tubes along the entire height of the column. This maximizes winter light and causes much of the light on the interior to be relatively diffuse. Once the front row of plants becomes mature, they can be harvested to allow more light penetration to the interior of the columns, or the most recently planted columns can be placed in the front and the mature plants slid to the back of the mass. Using multiple inserts the towers can also be planted to "conveyor" style production, placing young plants in an upper insert and sliding mature plants down to the bottom of the towers, thereby insuring that nitrification processes stay constant throughout the planting and harvesting procedures.

The towers also require a lot less space. My initial 300 gallon system utilized vertical aeroponic tubes, NFT troughs, and gravel beds and occupied roughly the same amount of space that a single one of my 2000 gallon systems currently occupies. By shifting my production from the horizontal plane to the vertical plane, I'm able to increase my production a minimum of 4 times as a function of horizontal growing area. During the winter months my production also seems to improve due to the low sun angle, despite the shortened day length.

The process of developing these towers has been a great experience. As someone with deep roots in the agricultural community, it's easy to get gloomy about the future of food production and the responsibility of feeding a growing world on fewer acres with fewer resources, but every time I see my towers I'm reminded that it can be done. In fact, it is being done by hundreds of people around the world, tinkering in their home workshops, fuelling an innovation revolution that includes sustainable agricultural practices like aquaponics. I'm excited to see what the future holds for aquaponics and vertical food production, and I'm honoured to labour alongside so many aquaponics practitioners who share that excitement. I believe that we are building a new age of plenty that will feed our children and change the nature and future of agriculture. ●

# Using WORM CASTINGS in Aquaponics

By **Louis Kinstler**

**Most of the** time I like to sow seeds directly into grow beds usually on the way past, amber ale in hand. Then try to work out what I planted once it comes up. This method while working well does require a lot of thinning out once the plants start coming up. Removing badly placed plants wastes nutrients that could be used to grow something else.

Using seedlings allows for more uniform planting, you know exactly what plants are growing and how many. Fresh seedlings are available at nurseries through out the year. Try to select young healthy plants that have not spent too much time on the shelf. Discounted and older stock should be avoided as these plants tend to bolt to seed.

I've never liked the commercial soil mix used in punnets. Unwanted media ranges from sands, bark, anaerobic bacteria, wetting agents through to styrophone and granulated fertilizer. Most of which can be washed off without disturbing the plant too much. Aquaponics shows less transplant shock than other growing systems with most plants displaying no signs of shock other than a growth spurt that can last the lifetime of the plant.

My preferred media for seedlings is worm castings pressed into small blocks or cells.

Raising seeds in castings first allows for the plant to get a strong start and gives you more control when planting. There is also a wider range of seeds available. You don't need to wash off the roots as the castings are safe to add to the systems as worms are often added to grow beds or make there way there by themselves. Worms help convert fish solids to casting aiding in the mineralization of solids so they become more available to the plants. I use casting blocks of 20mm for most small seeds and 40mm for the larger ones.

Another benefit of using fresh castings is the amount of small worms and worm eggs that it contains. This helps add more worms to your aquaponics system. The castings I use are from worms fed on plant waste from the kitchen, cuttings from the garden, peat and fish poo form a swirl filter. This keeps more of the nutrients going back into the system while increasing the micro ecosystem in the grow beds.

The blocks are molded with a small hole or dent in the tops. Small punnet trays can also be used. Keep the casting moist at a warm temperature will have the seeds germinate quickly. Due to the speed at which the seedling grow, they tend to stretch without enough light. Stretching before the first set of leaves is okay as plants can be planted deeper into the grow beds to encourage more lateral roots to develop along the stem. Spare seedlings can be planted into soil gardens as the castings provide a natural inoculant to the root zone. Seeds have an optimal germination temperature, heating trays are usually 10 degrees above ambient. Tops of fridges and window sill make ideal seed starting areas.

You don't have to wait for germination to plant the casting blocks. Finer seeds can be pushed into small 5mm balls of castings to keep the seeds from washing deeper into the growing media. This allows for planting into reusable media like clay in net pots for floating raft systems. ●






# Picking from the patch

## It's been an interesting season.

By **Mark England**

Photo's by Mark England


**One of learning**, discovery, planting, replanting and of patience. I would normally avoid mentioning the season we are experiencing here in Australia as there are people from many parts of the globe reading this but I thought I'd pass on our experience of the coldest season and maybe give others some tips on winter growing.

This is our first year of having a veggie garden. With the amazing growth we experienced last Summer in the Aquaponics system I just naturally presumed it would also continue on in Winter. How wrong and right I was.

Winter means shorter days, cold wet weather and the growth is slow. The varieity of veggies on offer is also much smaller. We planted as many winter veggies that we could. We sourced heirloom varieties and things we'd never tried before.

Our first crop of beans was great and we were eating beans every day but a frost saw them finished over night. This was a real hit to our crop as we'd planted a number of seeds in the growbed, including the beans, by mixing them up in a bucket and scattering them all over wondering how they'd grow together. This was great till we had to pull out all the dead beans

> “So, my thoughts on winter: **Plant as much and as many different types as you can.**”


which meant we almost had to pull out the whole bed of everything as the beans were twisted and twined around everything else.

We took a deep breath and replanted with more winter veggies, this time in a grid pattern that would allow us to remove and replant without upsetting other plants if something needed to be moved.

But it isn't all doom and gloom. The fish tanks are always full from the winter rain and the trout we stocked at the end of last year are so full of life it's catching.

**Day 332: It's time to start harvesting some trout.**
You can follow their blog online at [www.harvest365.blogspot.com](http://www.harvest365.blogspot.com)

Our Aquaponics setup has an overflow system that when the tanks are full, allows a circular flow between two tanks creating a large amount of aeration. When winter fully set in the increased rainfall caused the tanks to be at capacity therefore the aeration is pretty much constant and this has been great for the fish. The rainbow trout came to life in just days and the flow on effect to the veggies was just as quick. This fish were eating more therefore producing more effluent. Our veggies started growing and growing.

We've been eating silver beet, spinach, leeks, cauliflower, cabbage, radishes, snow peas and all sorts of herbs. We have broad beans, purple beans, red onions, beetroot, bok choi, garlic, lettuce, rainbow chard, kohl rabi, raddichio etc. all coming on strong and in the next few weeks we will be starting to harvest them.

So my thoughts on winter. Plant as much and as many different types as you can. It's slow going but once things start happening you will have an amazing array of winter produce that can be used in hearty winter dishes. Experiment with new types of veggies that can offer some variety to the normal ones you may be accustomed. Most of all if at first things don't seem to be working just wait longer. Enjoy the slower pace of winter and hold out for those great winter veggies that will warm your bones in a soup or casserole made from your patch. ●



# The role of Spiders in your aquaponic system

By Faye Arcaro

Photo's by Faye Arcaro

**Say the word** "spider", and instantly some people's skin crawls or you conjure up an image of a spider sitting on your shoulder without you knowing it. Sure, spiders can be seen as scary, but this is only because they have been used in the media depicting them as dangerous or as pests. This of course is not true in reality, although granted, there are some spiders in the world best left alone and be avoided like the Australian Redback or the Sydney Funnel-web. They can cause serious damage, but hardly any deaths of late, due to anti-venom being more readily available.

Spiders are more abundant on earth than all the vertebrate species combined. They are needlessly feared despite the fact that most spiders are harmless, their fangs just are not strong enough to pierce human skin, or their venom is of little consequence to our bodies.

Spiders are marvels of evolution and have managed to carve out for themselves a unique niche in the natural world. A spider is one hundred percent involved in its environment although it manages to hide just outside of everyday life. They are useful creatures to have in the garden and can save you lots of money and effort if you know how to manage them.

Spiders are hunters and their web spinning or ambush techniques have made them amongst the most successful hunters on earth. They will eat insects smaller or the same size as themselves with the odd bumper catch being bigger than them. Spiders that feed on plants and insects go about their job collecting nectar from flowers and thus helping with pollination. They can also help keep the insect pests under control, while small birds are likely to keep them under control.

> “Spiders are marvels of evolution and have managed to carve out for themselves **a unique niche in the natural world**”

Observe a spider’s web when next you have the chance. These iconic webs of silk are so intricate and serve as nurseries, homes and hunting traps. Different spiders will produce different webs, some come with trap doors and others use fluffy or sticky fibres which easily snags a prey. The orb web is the most common and is instantly identifiable due to the uniform pattern and spiral shape. It is believed that a spider spins two types of webs, one that is sticky and one that is not and the spider knows the difference, hence they never get stuck in their own webs.

Do take into account though, spiders are opportunists so they will catch and eat any insects which come their way. With expert techniques, spiders can be most effective dispatchers of insects in your system. They are a vital link in the food chain which will help you when your garden is overrun with bugs.

They are an accompaniment to the commonly identified “good” pests like bees or beetles which live in harmony with vegetables, fruit, flowers or any other type of plants.

If you would like to create a habitat for spiders, try not to be too tidy and if a small web appears beneath a growbed or in a crevice of pipework why not leave it be. Spiders like to be left alone, although if you remove their web they will just create another one.

Long term plants, foliage and leaf stalks provide an ideal habitat for spiders to camoflauge themselves and they are certainly masters of disguise. Allow some plants to flower and set seed, attracting food for them.

Avoid harmful chemicals and pesticides and let nature do its work for you.

Next time you are playing in the aquaponic garden have a look amongst the tomato flowers that have dropped into the growbed and see if you can find the matching spider that looks like a shrivelled flower. I bet if you stay still long enough you will see them going about their business, unaware that you are even there. ●

*Masters of camoflauge this one hides along a mesh trellis*

*St Andrews Cross Spider amongst the chives growing in the floating raft system*

*Spiders are often undetected, this one resembling an old tomato flower until the unsuspecting prey comes along. In this case a black soldier fly is the victim*

# Man on a mission

## An Interview with Travis Hughey

**Catching up** with Travis Hughey can be challenging, but it is worth the effort. Hughey is the founder of the Barrel-ponics™ movement in the U.S. and is, without a doubt, one of the icons of American aquaponics. These days he is also raising free-range chickens, building a mushroom growing facility, experimenting with vegetable oil powered generators, and travelling to China. And aquaponics… lots of aquaponics.

Hughey is a witty, charming renaissance man whose deep Christian religious roots permeate everything he does, including aquaponic systems design. Talking with him takes you on a fascinating intellectual journey from African missions to fiberglass boat making to food politics to the

challenges and opportunities of operating a 7 acre farm in rural South Carolina. Hughey never takes anything at face value and exudes the optimistic perspective that everything can be improved. He is an idea factory; pondering how to improve African relief agencies ("the key is to have lots of people doing small things that they are fully invested in") to how to produce a better chicken egg ("water hyacinth is an amazing source of feed for both my chickens and fish"). The following is based on a conversation that we had on June 19, 2010.

**Q – So Travis, how did you get involved in aquaponics?**

**A –** I had a keen interest in aquatic organisms even as a young child. Our family owned a house on a creek in Missouri so as a child I started on a quest about how living things work. Later I pursued a degree in Biology at Oral Roberts University which I didn't finish because I ran out of money. Next I went into the trades, learning everything from metal fabrication to land surveying. I tried it all, but spent close to 25 years of my career as a marine mechanic, satiating my urge to be around aquatic things. I had my own business for a while repairing boats around Charleston. Eventually I was able to afford my first piece of dirt and pursue gardening and small animal husbandry. This led to the purchase of a greenhouse from a nearby school. In looking for something unique to do with the greenhouse I researched hydroponics. Later I visited a tomato production greenhouse and was disturbed to find that the spent nutrients were labeled as hazardous waste. Fortunately I stumbled onto the term "aquaponics" in 2000 – 2001 and joined the S&S list serv, where Tom and Paula Speraneo were birthing the backyard aquaponics movement. I ordered their manual.

**Q – How did Barrel-ponics™ come about?**

**A –** I started building a mold for fiberglass grow beds and then my wife and I attended a conference in spring 2003 put on by Aquaculture International in Bryson City, North Carolina. There was a man there named Frank McNeely who was actually doing aquaponics in bathtubs. Seeing repurposed materials caused something to light up in me. By the time I got home I had figured out how to use barrels and Barrel-ponics™ was born! At first I built an S&S type system using 36 barrel halves with a 1000 gallon tank for a total cost of about $2500. The first time seeds burst out of the gravel I was hooked. There is just nothing more fulfilling than seeing creation succeed at our fingertips. Little did I know how far this "barrel thing" would go.

**Q – So how did your organization, Faith and Sustainable Technologies, come about?**

**A –** In 2001 I participated in a mission trip to Togo West Africa. I wanted to see if people in developing countries could take advantage of the opportunity to use this system to feed themselves. I'll never forget a farmer I met in Kenya who kept asking "where's the soil". I kept patiently describing aquaponics to him and he finally said "I fully understand what you are saying now – there is no soil, you grow plants in rocks, how can this be? If I can grow plants in rocks no child in Kenya should go to bed hungry."


There are multiple layers to what this technology does. There is an empowerment that comes with it that may help people tackle other problems as well, such as water conservation and as a fast way to reclaim bad soils. Around Lake Victoria the mismanagement of the environment by the manufacturing of charcoal has caused top soil to be washed off into the lake. They need to completely rebuild that soil. The key to doing a massive job like that is to have lots of people doing small things, i.e. decentralize the power. Food security could be eliminated as a risk if we all just produced even a portion of our own food.

**Q – So what was next for you?**

**A –** In October of 2003 we built our first system. We soon had vines with tons of tomatoes and by January we were growing papaya. At the time there were myths that you couldn't grow tomatoes and root crops, which hopefully we have dispelled by now.

In the spring of 2004 I built the first prototype Barrel-ponics™ system with the goal of making aquaponic technology doable in developing countries where microprocessors, float switches, and timers just aren't available. The day I started working on the flood valve it wasn't working very well under low flow situations like you might find in developing countries. I sat down and prayed, and within 1 – 1 ½ hours I had a working unit that would work on a trickle flow rate (a trickle). God has given me the secret to feed millions, like the little boy in the story of the fishes and the loaves. That is why the manual is free.

We ended up staying in that house for a little while, then sold it, got debt free, and have been doing mission work ever since: sharing the gospel and managing local resources. We were blessed to be able to take the windfall from selling our property at the top of real estate bubble and use that money to help people get aquaponics going.

In 2005 we published the Barrel-ponics™ manual, and in 2007 we made it available


online. Since then we have had over 27,000 downloads.

**Q – Any more trips to Africa?**

**A –** I've made several more trips to Africa trying to get aquaponics to take hold with limited success. I find that what holds our progress back is that unless someone is personally invested in their destiny it pays them to be dysfunctional. I think this is why there is an inverse relationship between foreign aid and a country's GNP. I've found that if someone takes the manual and builds the system themselves, without outside funding, they will succeed. But, without exception, every donor funded project has failed. People need an opportunity to be invested in their destiny and we need to use our resources to partner with them on that investment. We all need to have something at risk.

**Q – So what are you up to now?**

**A -** I now have a 7 acre farm with 8 different versions (soon to be 9) of Barrel-ponics™ systems ranging from a single barrel with a 5 gallon flood tank to 700 gallons with 37 barrel halves. I'm also raising tilapia and selling 6 varieties of fingerlings. I have an above ground pond that grows water hyacinth feed for fish and chickens. (I'm a big fan of water hyacinth which I find grows well and is so much easier to manage than duckweed). I have a free range layer operation with about 250 hens that produce high quality eggs which I sell to restaurants. The restaurants, in turn, save their prep table clippings to complete the food cycle. I'm currently working on building a mushroom facility and I'm working on 2 more aquaponic systems with 80 barrel halves in each and a 3000 gallon in-ground tank for the farm and for vegetables for the restaurants. I generate the power for the aquaponic part of the farm with a vegetable oil generator. I'm also planning on using horse manure for a compost heating operation. Finally, I'm going to China in the last week of July and the first week in August to build a system which will be off-grid for a training program.

**Q – What are your thoughts on the future of aquaponics in America?**

**A –** Personally I think that here in America it is ironic that we are thought of as being on the cutting edge of technology and innovation, yet for some reason aquaponics is struggling for acceptance into the mainstream. Perhaps it is because both the core disciplines of aquaponics (hydroponics and aquaculture) are perceived as mysterious, and have somewhat tarnished reputations. The beauty of aquaponics is that it solves the problems of both.

The home aquaponics market is wide open and there is a golden opportunity with the green movement, but we are going to have to be found by main-stream media in order to make that happen. ●

# Aquaponic workshops

**Aquaponics has grown** substantially over the past three years and interest as well as enthusiasm in the industry has dramatically increased. With a rise in people interested in setting up their own aquaponics systems at home, seasoned aquaponics enthusiasts are sharing their extensive knowledge in the field, by hosting aquaponic workshops.

**Workshops have been held at the Backyard Aquaponics shop every month since May, 2009.** The first workshop spanned a comprehensive three hours and covered the basics on aquaponics, particularly focused on our climate and region of Western Australia. The Backyard Aquaponics workshops now run for two hours and cover a wide range of information. Each participant takes home an information package with course notes as well as electronic copies of the BYAP magazine. Our workshops are quickly booked out and we often have waiting lists for our next workshop.

Aquaponics workshops have proved to be popular and a few workshops have also been held down the east coast of Australia by local aquaponic system suppliers. Often workshops and get togethers are hosted by small groups of forum members who bring together all of their knowledge and experience on aquaponics, these workshops are often advertised on the BYAP forum and in local newspapers. They vary in time and information but are always great fun to attend and worthwhile.

Aquaponics workshops are not just limited to Australia; they have even been hosted overseas, particularly in the United States. These workshops are held by various people, most notably Rebecca Nelson and John Pade, who have been involved in aquaponics for many years. Rebecca Nelson is a well-known author, who has published several very informative manuals on aquaponics and continues to develop her ideas and theories, which are shared with participants at her workshops. Her Partner John Pade, also plays a pivotal role in their workshops. Travis Hughey has also held some workshops on barrelponics (building a system using barrels) in the U.S.

No matter where or which workshop you attend, all are a fantastic place to meet like-minded people who are passionate about aquaponics and growing their own fresh produce at home. Workshops offer all participants a chance to express their ideas, share their experiences and learn something new and most of all, ***have fun!***







# CONVERSION TABLES

**For your reference**

| Metric Length | | Imperial |
|---|---|---|
| 1 millimetre [mm] | | 0.03937 in |
| 1 centimetre [cm] | 10 mm | 0.3937 in |
| 1 metre [m] | 100 cm | 1.0936 yd |
| 1 kilometre [km] | 1000 m | 0.6214 mile |

| Imperial Length | | Metric |
|---|---|---|
| 1 inch [in] | | 2.54 cm |
| 1 foot [ft] | 12 in | 0.3048 m |
| 1 yard [yd] | 3 ft | 0.9144 m |

| Metric Volume | | Imperial |
|---|---|---|
| 1 cu cm [cm³] | | 0.0610 in³ |
| 1 cu decimetre [dm³] | 1,000 cm³ | 0.0353 ft³ |
| 1 cu metre [m³] | 1,000 dm³ | 1.3080 yd³ |
| 1 litre [l] | 1 dm³ | 1.76 pt |
| 1 hectolitre [hl] | 100 l | 21.997 gal |

| Imperial Volume | | Metric |
|---|---|---|
| 1 cu inch [in³] | | 16.387 cm³ |
| 1 cu foot [ft³] | 1,728 in³ | 0.0283 m³ |
| 1 fluid ounce [fl oz] | | 28.413 ml |
| 1 pint [pt] | 20 fl oz | 0.5683 l |
| 1 gallon [gal] | 8 pt | 4.5461 l |

| USA Volume | | Metric |
|---|---|---|
| 1 fluid ounce | 1.0408 UK fl oz | 29.574 ml |
| 1 pint (16 fl oz) | 0.8327 UK pt | 0.4731 l |
| 1 gallon | 0.8327 UK gal | 3.7854 l |

| Metric Mass | | Imperial |
|---|---|---|
| 1 milligram [mg] | | 0.0154 grain |
| 1 gram [g] | 1,000 mg | 0.0353 oz |
| 1 kilogram [kg] | 1,000 g | 2.2046 lb |
| 1 tonne [t] | 1,000 kg | 0.9842 ton |

| Imperial Mass | | Metric |
|---|---|---|
| 1 ounce [oz] | 437.5 grain | 28.35 g |
| 1 pound [lb] | 16 oz | 0.4536 kg |
| 1 stone | 14 lb | 6.3503 kg |
| 1 hundredweight [cwt] | 112 lb | 50.802 kg |
| 1 long ton (UK) | 20 cwt | 1.016 t |

| Temperature Celcius | | Fahrenheit |
|---|---|---|
| 0°C | | 32°F |
| 5°C | | 41°F |
| 10°C | | 50°F |
| 15°C | | 59°F |
| 20°C | | 68°F |
| 25°C | | 77°F |


**This edition of the magazine** sees us take things forward another step with a printed version becoming available. The magazine will be available either as an electronic subscription, or in a printed format. For current subscribers who wish to receive printed editions, we will be sending out details of how to upgrade soon.

Work is well under way on the **tenth edition** of the magazine. We will continue to showcase systems belonging to members of the online discussion forum, there will be information on vegetables and plants well suited to aquaponics systems, plus lots of useful hints and tips.

***It's promising to be an exciting issue, packed full of information.***

**Issue 11 OUT SOON**

# Backyard Aquaponics Magazine
# Future Editions and Subscriptions

The ***Backyard Aquaponics Magazine*** can be purchased and downloaded in PDF format from ***www.byapmagazine.com*** either as individual issues, or as a yearly subscription. Alternatively, we can mail you a copy of the magazine on CD-Rom, or DVD.

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